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(71) Applicant: Empresa Brasileira de Pesquisa Agropecuaria - EMBRAPA
Brasilia, DF 70770-901 (BR)

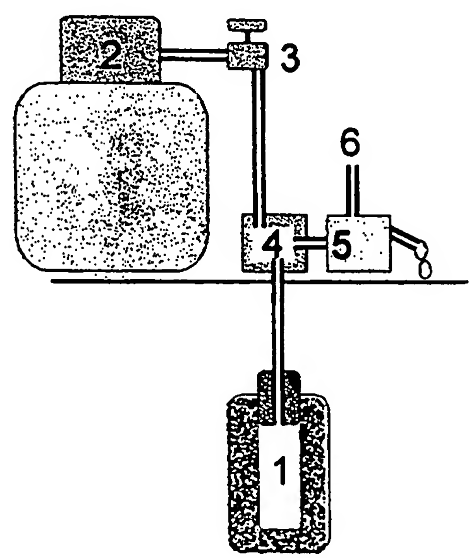
(72) Inventor: Calbo, Adonai Gimenez
Brasilia, DF 70770-001 (BR)

(74) Representative:
Grünecker, Kinkeldey, Stockmair & Schwanhäusser Anwaltssozietät
Maximilianstrasse 58
80538 München (DE)

(54) Gas irrigation control system based on soil moisture determination through porous capsules

(57) The present invention refers to a gas irrigation control system operated through gas pressure which utilizes porous capsules installed in the soil in appropriate positions, according to the stage of development and to the type of crops. When the soil's matric power is sufficiently negative, the capsules' pores are free from obstruction and the gas from a flow controller leaves through those orifices; this causes the pressure to drop and starts the irrigation system mechanically, electrically or electromechanically. The same systems close the water flow when the soil moisture rises above the critical level, thus causing the obstruction of the capsule's pores and consequently an increase in the gas pressure.

FIGURE 1



Description

FIELD OF THE INVENTION

[0001] The present invention refers to an irrigation system automatically controlled through porous capsules that are installed in the soil with the aim of determining the level of critical moisture for irrigation. The depth of the capsules in the soil will depend, among other factors, on the crop to be irrigated and on the development of the roots. The capsule functions through the depressurization caused by the opening of its pores when the soil moisture becomes lower than what is considered critical, according to the characteristics of the porous capsules used. This gas depressurization acts on appropriate devices, such as differential valves and pressure switches.

[0002] The irrigation may be activated by appropriate devices, such as pressure switches, differential valves, level controlling ball-floats, etc.

BACKGROUND OF THE INVENTION

[0003] The available soil irrigation systems present various levels of complexity and may be divided in two groups; the criterion for such division is whether or not they depend on the soil moisture as the determining parameter for the moment to activate irrigation. The independent systems are automatically activated at previously set time intervals based on soil and weather conditions, and on the type of plant, ignoring, thus, the plants' real needs. Examples of such systems are described in documents US 5882141 and EP 71176.

[0004] Thus, the quantitative determination of the best moment to irrigate remains a challenge. Such decision is usually based on empirical and qualitative criteria, and the commercial use of soil moisture sensors for irrigation control is still, generally speaking, very limited. Some of the best known sensors are the porous capsule tensiometers, which operate in a regime of hydric saturation.

[0005] Irrigation systems that use porous capsules or porous elements fixed to the ground do not always do so as a means of measuring the soil moisture. The systems described in documents US 3840182 and FR 2196744 can be cited as examples of such: the porous element has the function of controlling the release of water so that the plant may have practically continuous supply of water, independently of the soil's saturation level. The disadvantage of such systems is the fact that if the natural evaporation rate is higher than expected, the water supply might not be sufficient to provide for the plants' needs.

[0006] Another way to solve this problem has been the use of tensiometers to measure the soil moisture. However, the tensiometers used for irrigation control are usually quite voluminous, so as to be able to activate the mechanical or electronic pressure switches without the need of an excessively long response time. This problem is aggravated by accumulation of air within the tensiometer's pipes. Due to their compressibility, the air bubbles cause the volumes of water exchange per tension variation unit to increase exponentially as the water tension module asintotically approaches the barometric pressure. Therefore, the tensiometers are limited to a range of work between zero and the barometric pressure. It occurs even in the tensiometers whose capsules are covered with thinly porous material, in which such limitation persists due to the air bubbles that form in the larger cavities connecting the capsule to the pressure sensor. Besides, the thinly porous capsules have low hydraulic conductivity, a fact that makes the response time too long. Document US 4567563 describes an irrigation system with a tensiometer which has been made more automated and complex in order to provide for the limitations of such type of moisture gauge.

[0007] The limitations presented by tensiometers may also be solved by the system described in document US 3874590, which determines the soil moisture through a sensor based on the expansion and retraction properties of a water absorbent material in contact with the soil. The sensor commands an on/off valve that starts irrigation when the absorbent material is retracted (dry soil) and cuts the water supply when the material is fully expanded (moist soil). This kind of sensor presents the same disadvantages as the tensiometers.

[0008] Document BR PI 9003611 presents the hydromarker (*hidrobalizador*), a sensor used in irrigation systems which determines the soil moisture's point of recharge based on the energetic state of the water in the soil, taking into consideration the critical point of the soil's blade of useful water without the need for complex calculations and interpretations that require qualified personnel. Such device is presented as a means to eliminate the disadvantages of the tensiometers known in the market; however, it does not solve one of the negative characteristics of previous tensiometers, i.e., the fact that they operate under hydric saturation.

[0009] The system being proposed now overcomes the difficulties presented by automatic irrigation systems based on sensors such as tensiometers.

SUMMARY OF THE INVENTION

[0010] The objective of the present invention is to provide an automatic irrigation system that uses porous capsules to determine the critical soil moisture for irrigation. In this system, the water within the porous capsule is replaced by a gas under much lower pressure than that necessary to force air through the pores of a capsule submerged in water.

[0011] It is a gas control irrigation system with the following characteristics: (a) porous capsule sensors (1) fed by a pressurized gas source (2) installed in the soil to determine the critical moisture according to the relation between the pressure within the capsule and the

tension of the water present in the pores balanced with the water in the soil; (b) means (5, 7) of supplying water to the soil activated by the variation of the gas pressure within the porous capsule; (c) a water distribution source (6); and (d) connecting pipes between the irrigation spots.

BRIEF DESCRIPTION OF THE FIGURES

[0012] **Figure 1:** Schematic drawing of a system assembled for punctual irrigation.

[0013] **Figure 2:** Schematic drawing of a differential valve that may be used as a transducer in the invented system.

[0014] **Figure 3:** Synthetic diagram of the invented system's functioning.

DETAILED DESCRIPTION OF THE INVENTION

[0015] The present invention's system is practical and simple, and it is formed, as seen in Figure 1, by a porous capsule (1) installed in the soil, a pressurized gas source (2) with a flow controller (3) to adjust the pressure to a lower level than that necessary to bubble air through the porous capsule submerged in water, and a T-shaped distributor (4), which connects the porous capsule used in the invention to a pressure transducer (5) that activates irrigation whenever the gas pressure drops due to gas leak through the porous capsule in insufficiently moist soil. The transducer (5) to be used may be a differential valve, a pressure switch or any other electromechanical device to activate and interrupt the supply of water from a reservoir (6). The pressure of the gas fed to the capsule is low - typically below 0.02 MPa. The system also includes pipes connecting the elements (1), (2), (3), (4), (5) and (6), as well as all the irrigation spots.

[0016] As the amount of gas released into the soil is very small, there are no serious limitations to using commercially available gases, such as those commonly sold as domestic fuel; still, other gases such as compressed air from tanks or compressors may also be used.

[0017] The water supply device is not of major importance in the present invention's system, and any electrical, electromechanical or even mechanical devices (valves, differential pressure transducers, ball-floats and pressure switches connected or not to hydraulic pumps) may be used, provided they are compatible with the functioning of the gas porous capsule (1). For punctual irrigation, it is preferable to use a differential valve (7), as depicted in Figure 2, in which the water flow is blocked when the gas pressure becomes sufficiently higher than the outward water pressure. When pressurization is involved, it is necessary to use electromechanical devices that activate water pumps, as mentioned above.

[0018] Figure 3 illustrates the simplicity of the present invention's automatic irrigation system As the soil dries, the water tension rises and the capsule releases water into the soil. Therefore, when the module water tension reaches a level higher than the critical tension - approximately the same as the porous capsule's bubbling pressure module - the pressurized gas starts leaking from the capsule (1) to the soil, causing the pressure to drop and opening a passage for the water in the differential valve (5), thus beginning irrigation. The water supply is maintained until the soil moisture rises to a level that blocks the capsule's pores, which causes the gas pressure to rise. Such rise will affect the device (5) or valve (7) and close the water flow in the device (5,7) when the moisture is higher than the critical level. The irrigation will only restart when the gas pressure drops again (due to a reduction in the soil moisture) and causes a new gas leak into the soil, thus beginning a new cycle.

Claims

1. Automatic irrigation system with the following characteristics:

    (a) porous capsule sensors (1) fed by a pressurized gas source (2) installed in the soil to determine the critical moisture according to the relation between the pressure within the capsule and the tension of the water present in the pores balanced with the water in the soil;
    (b) means (5, 7) of supplying water to the soil activated by the variation of the gas pressure within the porous capsule;
    (c) a water distribution source (6); and
    (d) connecting pipes between the irrigation spots.

2. System built in accordance to claim 1, **characterized by** the fact that it includes a flow controller (3) placed between the porous capsule (1) and the pressurized gas source (2).

3. System built in accordance to claim 1, **characterized by** the gas pressure in the source (2) being lower than the bubbling pressure of the porous capsule submerged in water.

4. System built in accordance to claim 1, **characterized by** the fact that the means (5, 7) of supplying water to the soil are commanded by the gas pressure within the porous capsule through a differential valve or another pressure transducer.

FIGURE 1

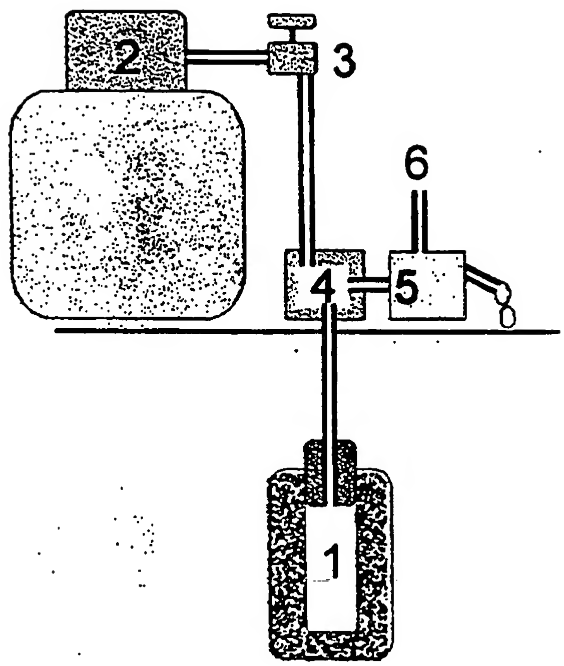


FIGURE 2

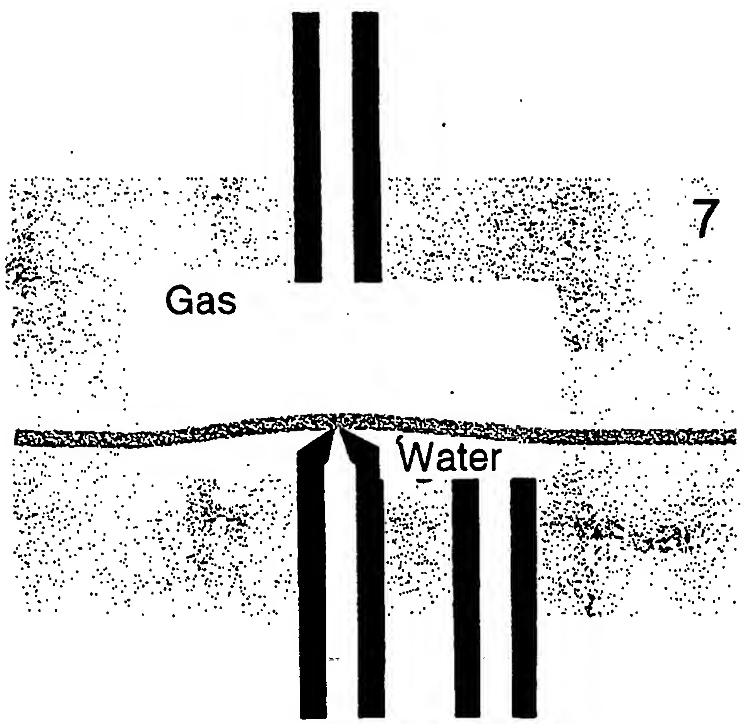
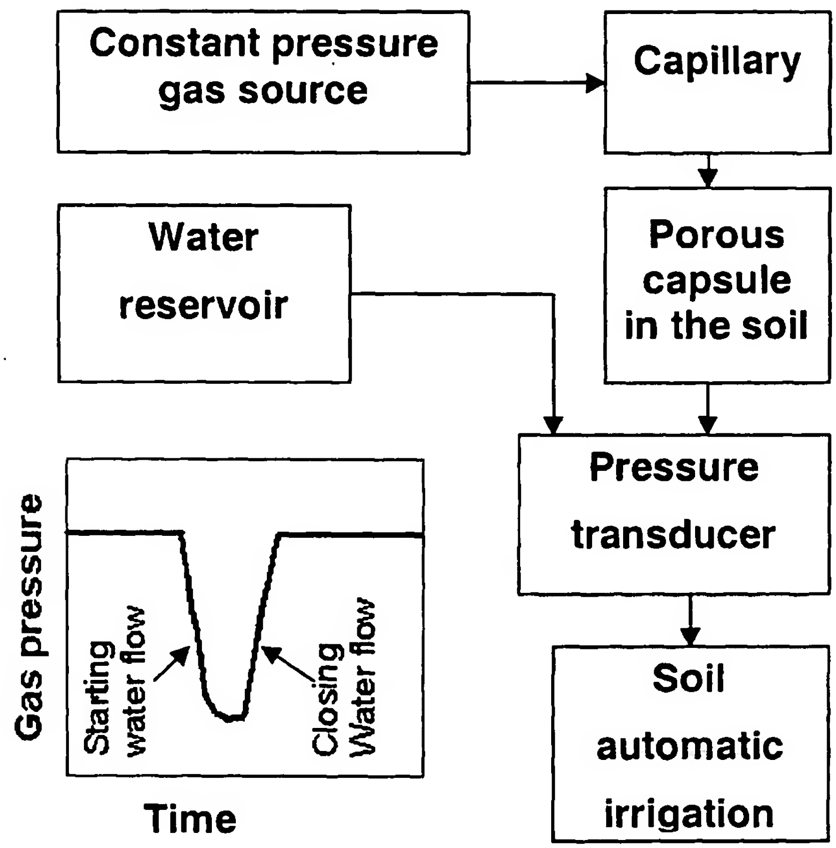


FIGURE 3


Constant pressure gas source
Capillary
Water reservoir
Porous capsule in the soil
Pressure transducer
Soil automatic irrigation
Gas pressure
Starting water flow
Closing Water flow
Time